

Customer No.: 31561  
Docket No.: 12009-US-PA  
Application No.: 10/605,782

**REMARKS**

**Present Status of the Application**

The disclosure is objected to because an incomplete sentence is found in paragraph [0004], lines 1-4. Claims 1, 3-7 and 9-16 are rejected under 35 U.S.C. 103(a), as being unpatentable over Maiti et al. (US Patent 5,885,870) in view of Kusumi et al. (US Patent 6,545,312) and further in view of Ohmi et al. (US Patent 6,551,948). Further, Claims 1, 3-7 and 9-16 are rejected under 35 U.S.C. 103(a), as being unpatentable over Mahajani et al. (US 2005/0062098) in view of Ohmi et al. (US Patent 6,551,948). Applicants have amended paragraph [0004] and canceled claims 7 and 9-12. Reconsideration and withdrawal of the Examiner's rejection is respectfully requested.

Customer No.: 31561  
Docket No.: 12009-US-PA  
Application No.: 10/605,782

### **Discussion of Office Action Rejections**

*The Office Action rejected claims 1, 3-7 and 9-16 under 35 U.S.C. 103(a), as being unpatentable over Maiti et al. (US Patent 5,885,870) in view of Kusumi et al. (US Patent 6,545,312) and further in view of Ohmi et al. (US Patent 6,551,948).*

MPEP 2142 provides "The examiner bears the initial burden of factually supporting any prima facie conclusion of obviousness." "To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations."

Applicants respectfully assert that Maiti et al. in view of Kusumi et al. and further in view of Ohmi et al. is legally deficient for the purpose of rendering claim 1 and 3-6 and 13-16 unpatentable for at least the reason that not every element of the claim was taught or suggested by the cited references such that the invention as a whole would have been obvious to one of ordinary skill in the art.

The present invention specifically teaches "...to form a silicon oxide layer as tunnel oxide layer on a semiconductor substrate; performing a plasma nitridation process to introduce nitrogen atoms into the silicon oxide layer" as taught in claim 1 and 13.

Customer No.: 31561  
Docket No.: 12009-US-PA  
Application No.: 10/605,782

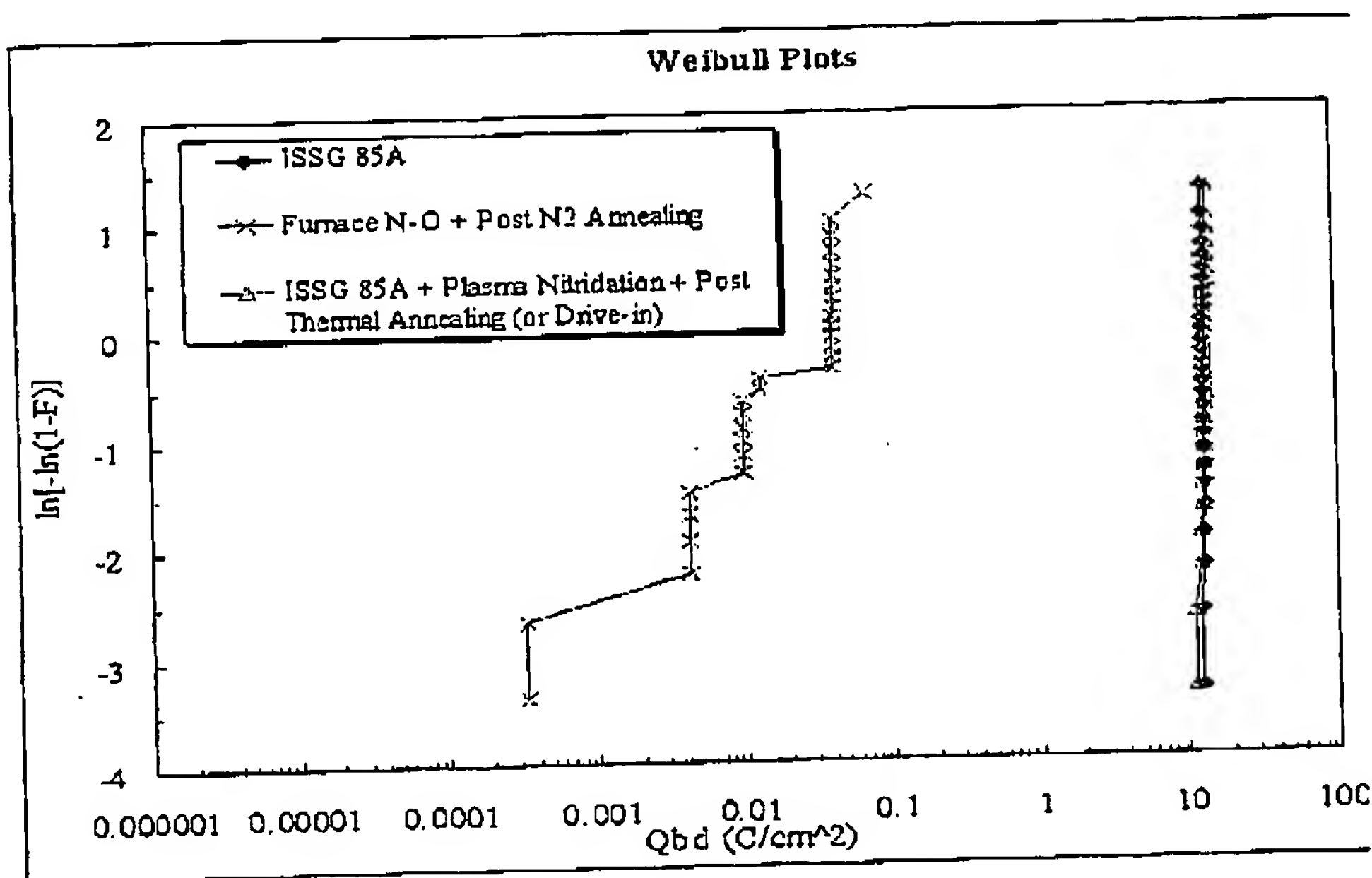
In Office action page 6 line 13 to line 18, the examiner states "Ohmi teach a nitridation process for tunnel oxide, also in a flash memory device, wherein a low temperature plasma nitridation process is used to improve the characteristics of the tunnel oxide for benefits mentioned in Ohmi. See ...column 3, line 15-26; column 5, lines 15-20; column 6, lines 44-53." In Ohmi's col. 5, line 15-20, it states "a nitride film having excellent leakage current characteristic is obtained for the inter-electrode nitride film...". In Ohmi's Col. 6 line 44-53 further states "...a tunnel insulation film interposed therebetween and a second electrode formed on said first electrode ...the insulation film having a stacked structure containing at least one silicon oxide film and one silicon nitride film". It is obvious tunnel insulation film is between floating gate and control gate, not on the substrate. The tunnel insulation film is not equivalent to tunnel oxide, which is under the floating gate, in the claimed invention. Maiti, Ohmi and Kusumi fail to teach that "...to form a silicon oxide layer as tunnel oxide layer on a semiconductor substrate; performing a plasma nitridation process to introduce nitrogen atoms into the silicon oxide layer" as taught in claim 1 and 13.

The claimed invention also has an unexpected result over the prior arts.

A. ) The inventor provides the experiments for comparing charge-to-breakdown (Qbd) of the claimed invention and Maiti et al with the result shown in Fig. 1 The line ( $\Delta$ ) indicates a result of one embodiment in the claimed invention "ISSG 85A + plasma nitridation + thermal drive-in". The line (x) indicates the result of the embodiment similar to Maiti et al. "thermal oxidation + Furnace nitridation + post thermal annealing (or drive-in)". Fig. 1 shows that the

Customer No.: 31561  
 Docket No.: 12009-US-PA  
 Application No.: 10/605,782

charge-to-breakdown ( $Q_{bd}$ ) of the process "Furnace N-O + Post N<sub>2</sub> Annealing" is very poor ( $<0.1$  C/cm<sup>2</sup>), and process of "ISSG 85A + Plasma Nitridation + Post Thermal Annealing (or Drive-in)" (one embodiment in our invention) perform comparable  $Q_{bd}$  ( $>10$  C/cm<sup>2</sup>). The claimed invention has an unexpected result better than Maiti.

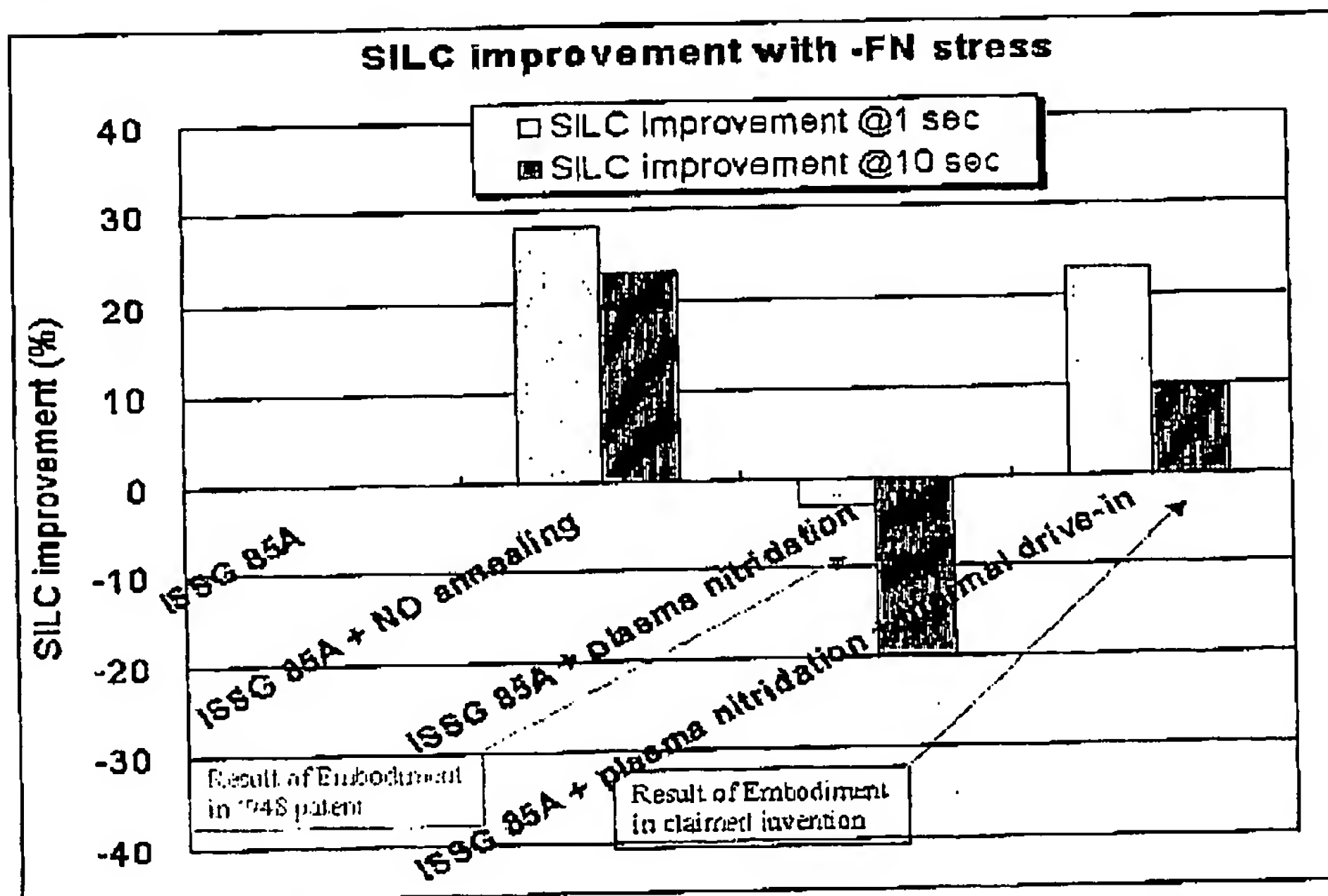


**Fig. 1 charge bread down test**

B.) Fig. 2 demonstrates the SILS measurement of claimed invention, Kusumi and Ohmi. The result shows that the level of "SILC" is  $>1E-4$  A which means the oxide has broken down by the -FN stress. Therefore the measured "SILC" is actually the high direct tunneling current.

Customer No.: 31561  
 Docket No.: 12009-US-PA  
 Application No.: 10/605,782

Kusumi only discloses ISSG oxidation is performed on the substrate. The condition is similar to "ISSG 85A" labeled in Fig. 2. Ohmi only discloses plasma oxidation process and plasma nitridation process on the silicon oxide layer in the tunnel insulation film, which is between floating gate and control gate. If it would have been performed on substrate, the condition is similar to "ISSG 85A+ plasma nitridation" labeled in Fig. 2. From Fig. 2, "ISSG 85A" and "ISSG 85A+ plasma nitridation" show poor SILC performance. In our experiment result we also find that if lacking of the post thermal annealing, the SILC performance (using the methodology in Fig. 2) will be degraded and even worse than that of ISSG 85A pure oxide. The result is worse than the embodiment shown in claimed invention.



**Fig. 2 SILC performance degradation by adding plasma nitridation only on ISSG oxide.**

Customer No.: 31561  
Docket No.: 12009-US-PA  
Application No.: 10/605,782

According to the above explanation on paragraph A) and B), Maiti, Kusumi or Ohmi alone does not good performance. There is no reasonable expectation of success. The references do not contain any suggestion (express or implied) that they can be combined, or that they can be combined in the manner suggested. There is no motivation to combine prior art references to solve the problem in the claimed invention.

Dependent claims 3-6 and 14-16 are submitted to be patentably distinguishable over the prior art of record for at least the same reasons as independent claims 1 and 13 from which these claims respectively depend, as well as for the additional features that these claims recite.

*The Office Action rejected claims 1, 3-7 and 9-16 under 35 U.S.C. 103(a), as being unpatentable over Mahajani et al. (US 2005/0062098) in view of Ohmi et al. (US Patent 6,551,948).*

MPEP 2145 V provides "Reliance on a large number of references in a rejection does not, without more, weigh against the obviousness of the claimed invention." The fact that a large number of references must be combined to meet the invention is evidence of unobviousness. The examiner fails to establish the evidence for prima facie conclusion of obviousness.

Applicants respectfully assert that Mahajani et al. in view of Ohmi et al. is legally deficient for the purpose of rendering claim 1, 3-6 and 13-16 unpatentable for at least the reason that not every element of the claim was taught or suggested by the cited references such that the invention as a whole would have been obvious to one ordinary skill in the art.

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Customer No.: 31561  
Docket No.: 12009-US-PA  
Application No.: 10/605,782

In Mahajani's [0035] it states "Next a first dielectric film composed of a first dielectric material, for example silicon nitride, is formed on and in contact with tunnel dielectric. First dielectric film is preferably ....using a low-pressure CVD (LPCVD) ...". It is not a "plasma nitridation" process.

Mahajan in combine with Ohmi fail to teach that "...to form a silicon oxide layer as tunnel oxide layer on a semiconductor substrate; performing a plasma nitridation process to introduce nitrogen atoms into the silicon oxide layer" as taught in claim 1 and 13.

Dependent claims 3-6 and 14-16 are submitted to be patentably distinguishable over the prior art of record for at least the same reasons as independent claims 1 and 13 from which these claims respectively depend, as well as for the additional features that these claims recite.

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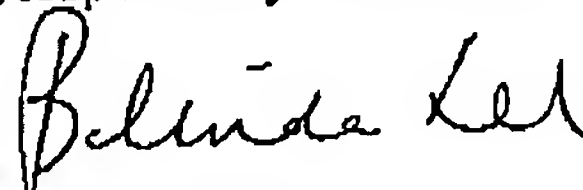
Customer No.: 31561  
Docket No.: 12009-US-PA  
Application No.: 10/605,782

**CONCLUSION**

For at least the foregoing reasons, it is believed that the pending claims 1, 3-6 and 13-16 are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

Date : *March 23, 2006*

Respectfully submitted,



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